Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE RESULTS OF FURTHER BREEDING EXPERIMENTS WITH PETUNIA

EDITH R. SAUNDERS

LECTURER, LATE FELLOW, NEWNHAM COLLEGE, CAMBRIDGE, ENGLAND

In view of the present discussion on the inheritance of doubleness in Petunia[1] and pending further investigation of the evidence in favor of an explanation based wholly or in part upon selective sterility such as has been described by Geerts[2] for *Œnothera Lamarckiana,* by Belling[3] for the Velvet "Bean" (*Stizolobium deeringianum* and other species) and by East[4] for species of *Nicotiana,* it seems desirable to make available the further results of the breeding experiments which have been carried out since the publication of the earlier data in 1910.[5] The two main facts established by the earlier work were

(1) That singles of the cultivated forms of *P. violacea, P. nyctaginiflora* and of various garden strains (Countess of Ellesmere, *hybrida grandiflora* and others) give only singles when self-fertilized or crossed with pollen of other singles.

(2) That these same singles give a mixture of singles and doubles in F_1 when crossed with the pollen of a double.

The later experiments carried out on the same lines and with the same kind of material have considerably widened the basis upon which these generalizations rest; while the fact that mixed F_1 families have now been obtained in the case of a new wild form as well as with one *nyctaginiflora* individual raised from wild seed, though not *proving* that the second statement would invariably hold good for singles of each of these two species, certainly increases the probability that this may be found to be the case.

---

[1] Frost, "The Inheritance of Doubleness in *Matthiola* and *Petunia,*" AM. NAT., Vol. XLIX, No. 586, p. 623, Oct., 1915; also Saunders, "Selective Partial Sterility as an Explanation of the Behaviour of the Double-throwing Stock and the Petunia," *Ibid.,* Vol. L, No. 596.

[2] "Beiträge zur Kenntniss der Cytologie und der partiellen Sterilität von *Œnothera Lamarckiana,*" *Recueil des Trav. Bot. Néerl.,* Vol. 5, 1909.

[3] "The Mode of Inheritance of Semi-sterility in the Offspring of Certain Hybrid Plants," *Zeitsch. f. ind. Abst. u. Vererbungslehre,* Bd. XII, Heft 5, p. 303, 1914.

[4] "The Phenomenon of Self-sterility," AM. NAT., Vol. XLIX, No. 578, p. 77, Feb., 1915.

[5] Saunders, "Studies in the Inheritance of Doubleness in Flowers," I. Petunia. *J. of Genetics,* Vol. I, No. 1, p. 57, 1910.

With respect to these more recent experiments I was able in 1911 to obtain a larger series of counts than had been possible heretofore. For the opportunity to carry out the work on this larger scale I was much indebted to Professor Bateson, who kindly had some 5,000 plants grown for me at the John Innes Horticultural Institution. The results may be summarized shortly as follows:

Seven crossbred singles out of matings in which the four strains mentioned above were variously combined, were self-fertilized. *Only singles were obtained,* viz., 1,200, 123, 89, 73, 33, 32, and 12 in the different families. Total 1,562 singles.

Fifteen singles were tested by crossing and pollen from 8 doubles was used to fertilize them. The single parents included

One *violacea* plant (commercial material, new stock).

Twelve F_1 plants the offspring of 4 singles (Countess of Ellesmere) which had been crossed with pollen from various doubles (*hybrida grandiflora*). Among these 12 were 4 of those which had yielded all-single families when self-fertilized.

One *hybrida grandiflora* plant derived from a mating between two singles each of which was the offspring of a single crossed with pollen from a double.

One F_2 plant derived from an F_1 single out of the mating *nyctaginiflora* × *hybrida grandiflora* (double), the F_1 plant having been crossed back with another double.

Thus doubleness was known to have been introduced into the pedigree only once in the case of the first-mentioned (*violacea*) seed-parent, thrice in the case of the last (F_2) plant. In the remaining 13 cases it was introduced twice,—in consecutive generations in the case of the group of 12 plants, with the skipping of a generation in the remaining instance. *Families were raised from each of these 15 plants and doubles occurred in them all.* The numbers obtained, as was to be expected from the more extended scale of the experiments, indicate a more uniform proportion of singles and doubles than was apparent in the earlier results. In many families the numbers clearly suggest a ratio of equality; in a few, however, there was a considerable excess on the side either of the singles or of the doubles. No connection could be traced between the proportion of doubles obtained and the number of times doubleness was introduced into the pedigree. The numbers in each family are shown below where the 15 seed-parents are indicated by the capital letters A to O and the pollen parents by the small letters a to h.

Parents	A × a	B × a	B × b	B × c	C × b	D × a	D × b′	E × b	F × a	F × b	F × d	F × e	G × a	G × b	G × c
F_1															
Singles	27	104	74	19	27	99	58	53	250	237	148	63	103	113	78
Doubles	36	63	67	47	22	100	56	51	216	256	207	42	65	63	106

Parents	G × e	G × f	H × d	I × a	J × a	K × g	L × e	L × f	M × c	N × f	O × a	O × b	Totals
F_1													
Singles	25	188	23	58	15	34	20	25	38	51	52	17	1,999
Doubles	40	101	25	78	14	29	17	30	13	39	39	15	1,837

How far these proportions are determined, as suggested by Frost,[6] by a condition of partial selective sterility can hardly be profitably discussed until further microscopic investigations have been made, but that this explanation forms a part, though possibly not the whole, of the explanation appears highly probable. At the time it seemed advisable to postpone further breeding until wild material was available for comparison. Though repeated efforts have been made to obtain seed of wild plants, they have, in the case of *P. violacea,* been so, far quite unsuccessful. In the course of 1912 and 1913 however, through the assistance of the authorities at Kew and of Sir Reginald Tower in Argentina, to whom I am much indebted, seed was obtained of wild plants of *P. nyctaginiflora* and also of two new unnamed wild forms (species, both white-flowered), all of which had been collected most kindly by M. Thays, director of the Botanic Garden at Buenos Aires. An entirely new stock of double material differing in nature as well as in origin from that previously employed was also now available. This was raised from

---

[6] *Loc. cit.*

(1) seed of a plant exhibited at the Conference on Genetics held in Paris in 1911, which had some flowers double and others apparently of a normal single structure. This plant had appeared in the grounds of the establishment of MM. Vilmorin-Andrieux et Cie at Verrières-le-Buisson. Some seed harvested from the single flowers, together with a small quantity obtained from the doubles was later most courteously forwarded to me by Dr. Haagedoorn;

(2) seed sent to me by Mrs. Francis of Ventura, California, of an interesting new strain of seed-producing doubles which she had succeeded in raising.[8]

The South American seed samples gave plants of uniform type in the case of the two new forms, each presumably being a distinct species. One of the two (referred to below as P.x.), the seed of which had been collected in Cordova, was crossed with pollen from a double raised from the seed of one of the single flowers on Haagedoorn's half-and-half plant, and also with two seed-giving doubles of the Ventura strain. *Each F_1 family showed a mixture of singles and doubles.* In the case of the former cross a large number of semi-double plants with the supernumerary petaloid structures small or few in number, were also obtained. The numbers recorded are given on page 552.

These 5 seed-parents as well as other individuals tested proved quite self fertile and set a good quantity of seed when self-pollinated.

---

[7] For an account of this strain see Mrs. Myrtle Francis [Shepherd] on "Double Seeding Petunias," *J. of Heredity*, Oct., 1915.

Single Parent	Double Parent	F_1		
Flowers White	Flowers Magenta	Flowers Magenta		
		Singles	Semi-doubles	Doubles
P.x. 1	Descendant of Haagedoorn's plant	15	54	23
P.x. 2	" " "	12	32	15
P.x. 3	" " "	5	32	4
Totals		32	118	42
	Flowers Rose Pink	Flowers White with Dark Tube		
P.x. 4	Ventura plant 1	14	—	15
P.x. 5	" " 2	3	—	2
Totals		17	—	17

Thus we have evidence that in a third species (for as such there seems good ground for regarding this wild type) doubles appear in F_1 when a cross is made with a double form. The behavior in this respect of the other new form has not yet been ascertained.

With regard to *P. nyctaginiflora* the seed of which was collected from Punta Ballena, Maldonaldo (Uruguay), it was noticed that the plants were not entirely uniform in color, some showing a very definite tinge of purple on the outer side of the flower tube, others scarcely a trace. Similar variations had also been observed in the original (1906) commercial material. Whether this variability is normal to the species or is an indication of crossing is not certain. It is somewhat remarkable that in this original material all the 8 individuals tested proved to be self fertile and yielded abundance of seed, whilst six self-pollinated flowers on three of the Uruguay plants taken at random did not yield a single seed. It seems unlikely that this result could be due to accident, or to a difference of conditions due to the fact that the 1906 plants were grown in the open, whereas the individuals grown from the wild seed were kept in pots in a cool house. Indoor treatment had not been found to affect the fertility of the other strains, and it is hardly likely that it did so here; but this point is now being verified. Only one Uruguay plant was crossed with pollen from a double (Ventura 2). From this cross the same result was obtained as with the commercial material. *F_1 was mixed,* the numbers recorded being 225 singles and 113 doubles.

So far, then, the material employed has furnished no exception to the statement that singles crossed with the pollen of doubles yield some doubles in F_1 though breeding true to singleness when self-fertilized or pollinated by other singles.

Unfortunately very little evidence is yet available as to the results of using the double plant as the seed-parent. Haagedoorn's plant was of an exceptional character and the Ventura plants, though more typical, showed considerable sterility. Only 5 plants were raised from the seed sent by Mrs. Francis. These were all double. Only one individual was obtained by self-fertilization of these plants and this was also double. A cross with a single (Countess of Ellesmere) produced only one offspring and this plant was lost before flowering. It is however hoped by a repetition of this mating to obtain an F_1 generation which will throw further light on the relation of the double to the single.

The following information received from Professor Bateson concerning a cross made at the John Innes Horticultural Institution by E. J. Allard unfortunately only came to hand after the above account had been forwarded for publication. In the mating in question a *nyctaginiflora* plant, one of a batch raised from a sample of the same wild seed as that from which my own plants were grown, was crossed with pollen from a pink-flowered double, a florist's highly cultivated type of plant. *More than 20 plants were raised in F_1 and all were single.* If we consider this number large enough to be taken as conclusive we should have in this experiment an exception to the results hitherto obtained and summed up in the general statement formulated above. We must then suppose that there exist in these *Petunia* forms certain singles and doubles the relation between which is such that doubleness completely disappears in the F_1 generation obtained from a cross between them.